

Information dynamics with opposite opinions

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August 22, 2018

Abstract

In our everyday lives new information comes from many means about certain topics, we take these inputs to then formulate our opinions and propagate it to those connected to us, creating a flux of information about a topic, in the present work we will consider a neuron like systems with actions potentials so simulate information propagation across a population, for this purpose we will consider every person as a neuron that has a positive threshold for its action potential for opinion 1 and neurons with a negative threshold for opinion 2 which is the opposite of opinion 1, in the following work we consider that when a neuron reaches its threshold it then sends a signal to everyone he is connected as a directed graph, the intensity of this signal is given by a gaussian of mean and variance inputted by a user so its a value between 0 and the threshold, those that share the same opinion will get closer to trigger themselves, while those with opposite opinions will take longer to trigger.

1 Model

In the following model we create a oriented graph which is not necessarily fully connected, but its connectivity is given by a input parameter in the model, for the model we consider the following parameters:

Parameter	Description	Domain
ρ	connectivity parameter	[0:1]
μ	mean of gaussian	[0:1]
σ	variance of gaussian	(0:1]
α	percentage of individuals with opinion 2	[0:1]

For the graph simulation we create 200 neurons and then each receives a random potential between -threshold and threshold, we also initialize the reduction scalar of the neuron β according to the gaussian function of mean μ and variance σ , after every neuron is initialized we then connect these neurons with the following algorithm

- Consider a neuron denoted by N_i
- We run a random number between 0 and 1 for every N_j for every $j \neq i$
- If the number if lesser or equal to ρ then i is connected to j , but j is not necessarily connected to i

Then after initialization the following algorithm will be done

- Every N_i with opinion 1 will increase their potential by input value which is a small constant.
- If $N_i >$ threshold then we this neuron will trigger, making its potential under the threshold by the formula $V_i = V_i - \text{threshold}$ where V_i is the potential representing the information of neuron i .
- If the neuron triggers then all who are connected to it will receive part of its potential according to the formula $V_j = V_j + \beta * \text{threshold}$.

Keep in attention according to this formula neurons with the opposite opinion of the triggered one will get farther from the value of potential needed to trigger themselves, this works to model how contrary opinions may have information that disproves some of your own data and you need to

take longer to gather enough information to convince other people of your position, a trigger is as much a support of your opinion as something to hinder the opposite one.

After every neuron has interacted we then take the statistics of the number of triggers per simulation step as well as the mean value of the potential of the neurons, here representing the opinion (close to 0 the system is very divided) while closer to the thresholds there is a dominant opinion.

2 Results and discussion

For the results we will analyse how those parameters influence the dynamics of the system. first lets consider the dynamics where we got only one opinion: All the results were calculated with $\mu = 0.1$ and $\sigma = 0$

2.1 Opinion 1 pure

Lets first see how a non connected graph works on figure 1 , in other words $\rho = 0$

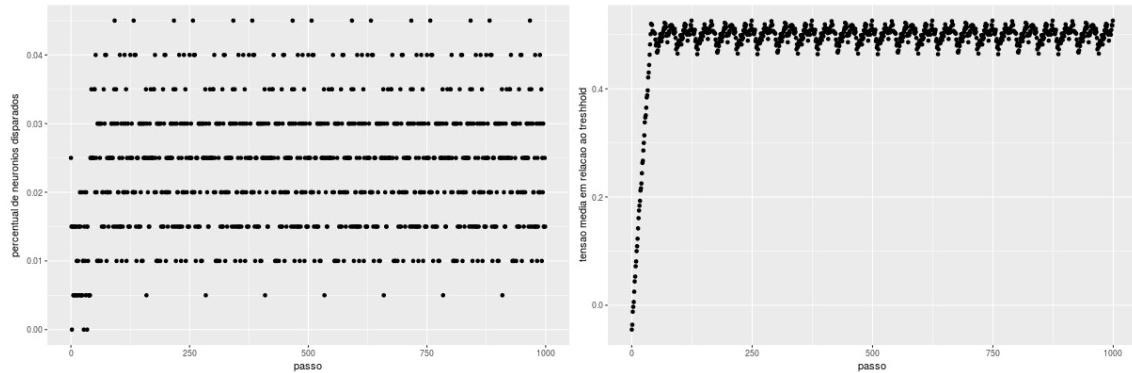


Figure 1: $\rho = 0$

Now lets consider see how a low connected graph works according to the figure 2 , using $\rho = 0.2$

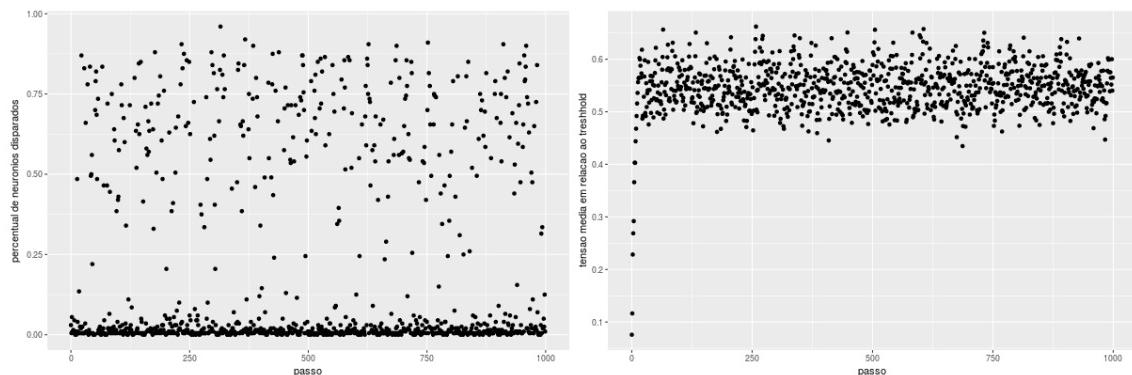


Figure 2: $\rho = 0.2$

Now with a $\rho = 0.5$ we can start to notice a smaller variance according to the figure 3

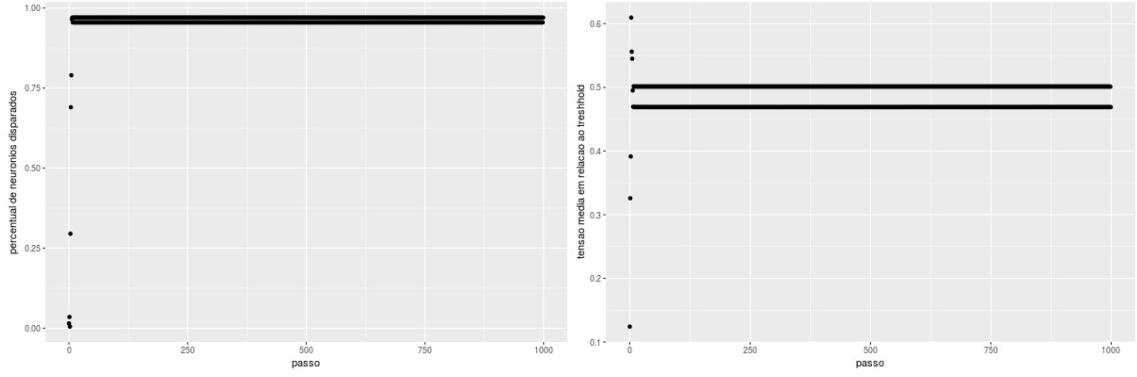


Figure 3: $\rho = 0.5$

Finally we consider a fully connected graph in figure 4, notice how the variance of the simulation is so close to 0 showing that the information is fully synchronized.

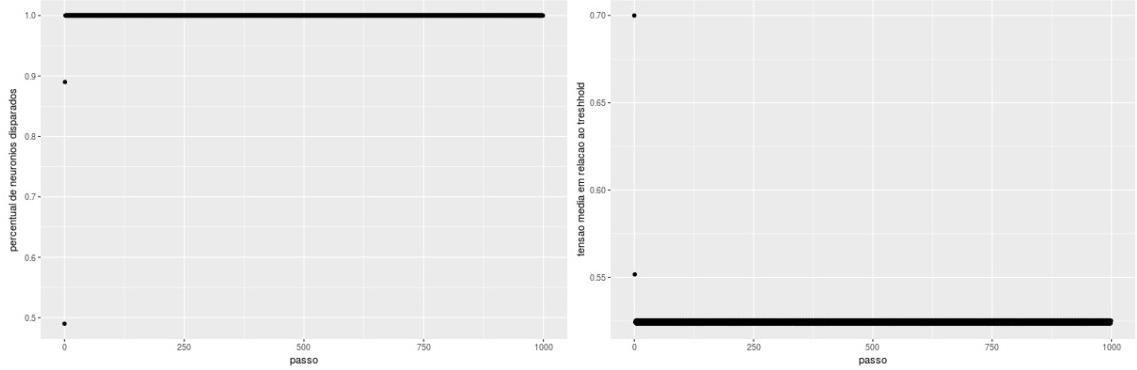


Figure 4: $\rho = 1$

2.2 Opinion 2 pure

We show here that opinion 2 pure is basically a mirror version of opinion 1 pure, with the only change being its potential is negative.

Lets first see how a non connected graph works on figure 5 , in other words $\rho = 0$

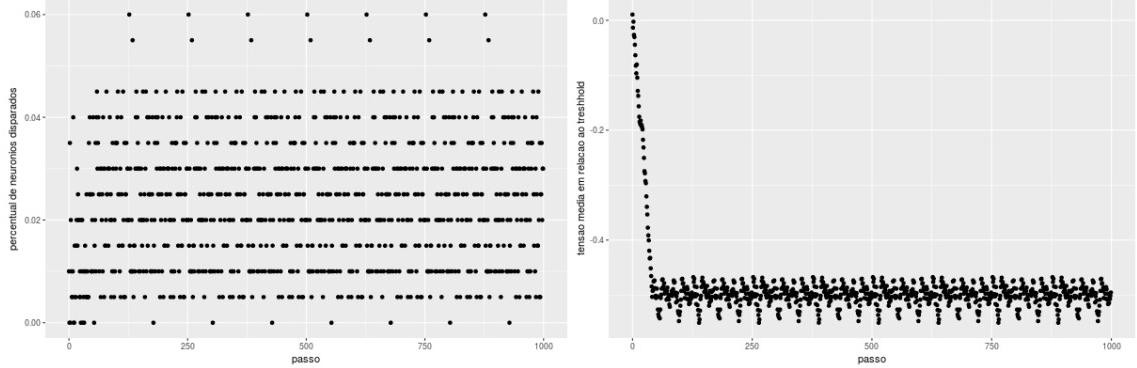


Figure 5: $\rho = 0$

Now lets consider see how a low connected graph works on figure 6 , using $\rho = 0.2$

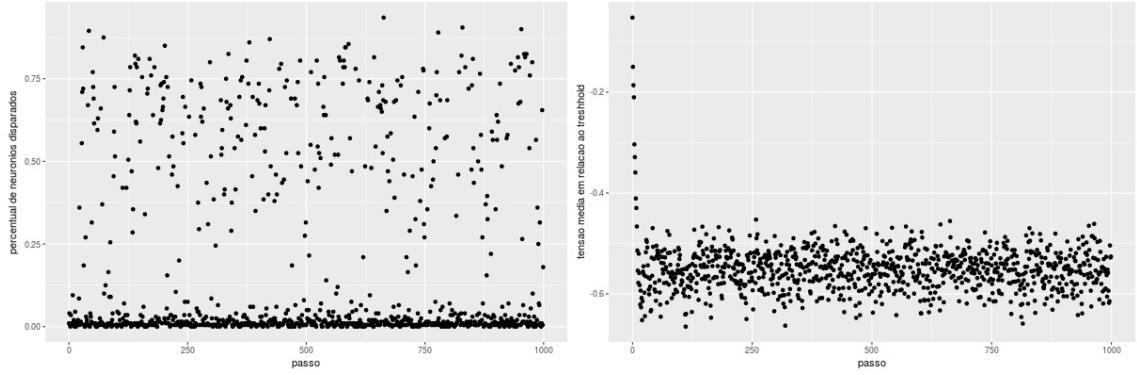


Figure 6: $\rho = 0.2$

Now with a $\rho = 0.5$ we can start to notice a smaller variance according to the figure 7

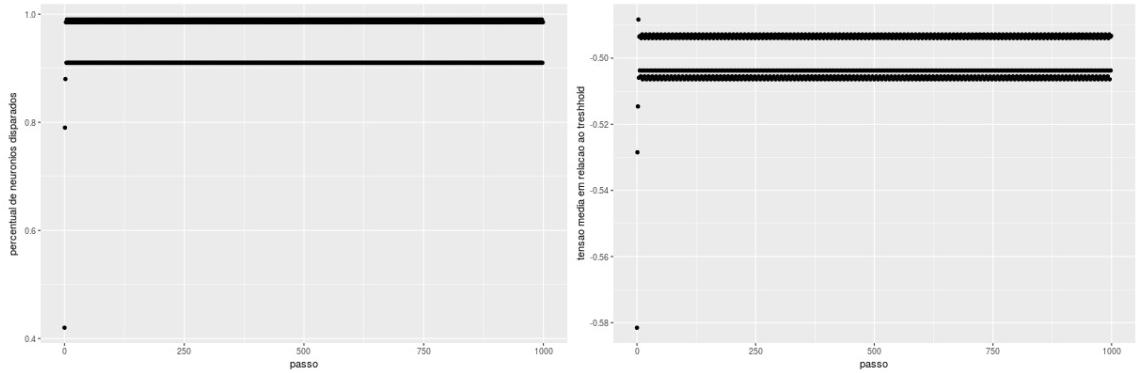


Figure 7: $\rho = 0.5$

Finally we consider a fully connected graph, notice how the variance of the simulation is so close to 0 showing that the information is fully synchronized on figure 8.

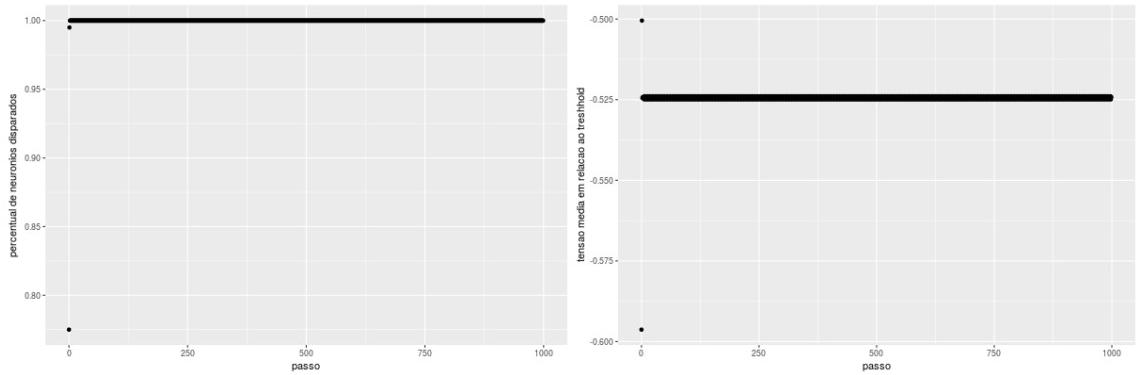


Figure 8: $\rho = 1$

2.3 Both Opinions

On the subsections above we analised the extreme cases $\alpha = 0$ and $\alpha = 1$, now lets consider a system where $\alpha = 0.5$

Lets first see how a non connected graph works on figure 9 , in other words $\rho = 0$

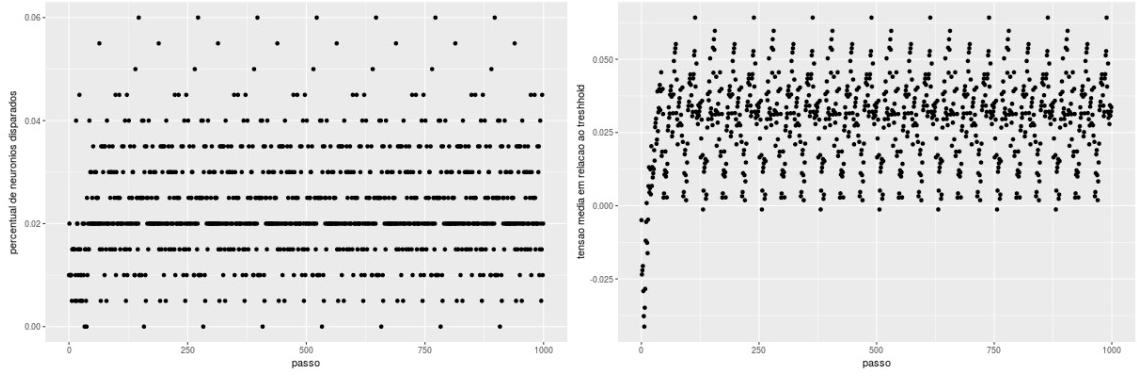


Figure 9: $\rho = 0$

Now lets consider see how a low connected graph works on figure 10 , using $\rho = 0.2$

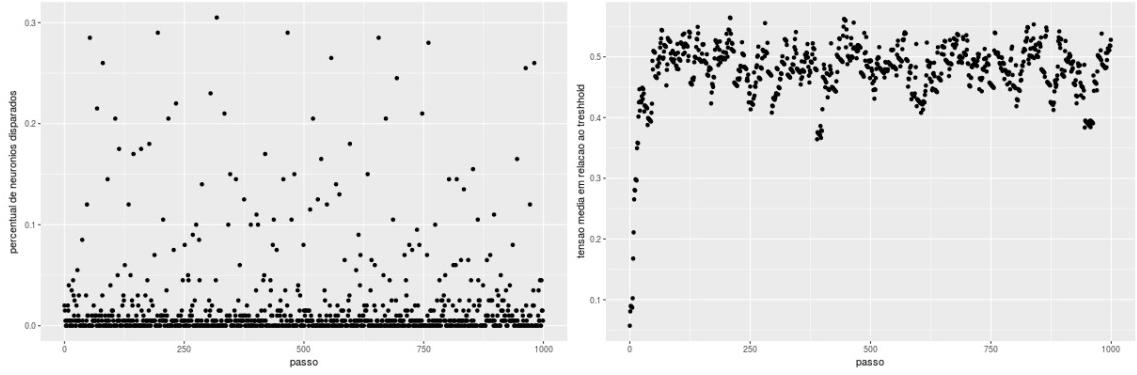


Figure 10: $\rho = 0.2$

Now with a $\rho = 0.5$ we can start to notice a smaller variance according to the figure 11

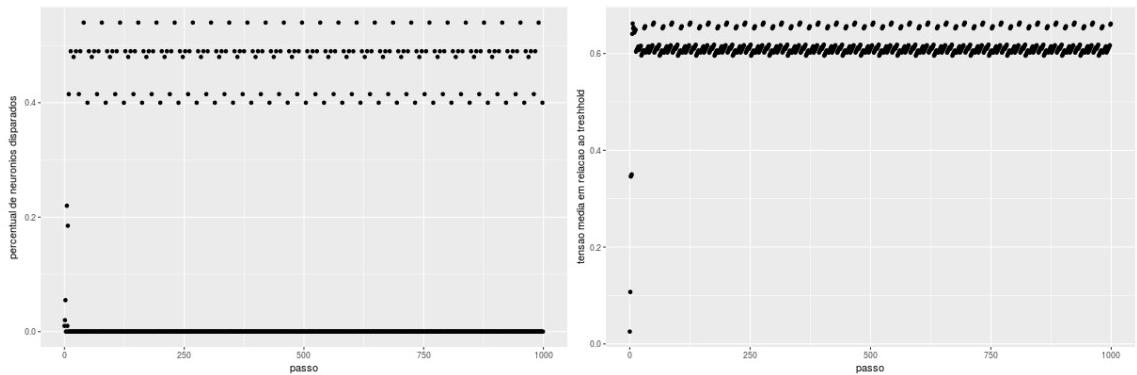


Figure 11: $\rho = 0.5$

Finally we consider a fully connected graph on figure 12, notice how the variance of the simulation is so close to 0 showing that the information is fully synchronized.

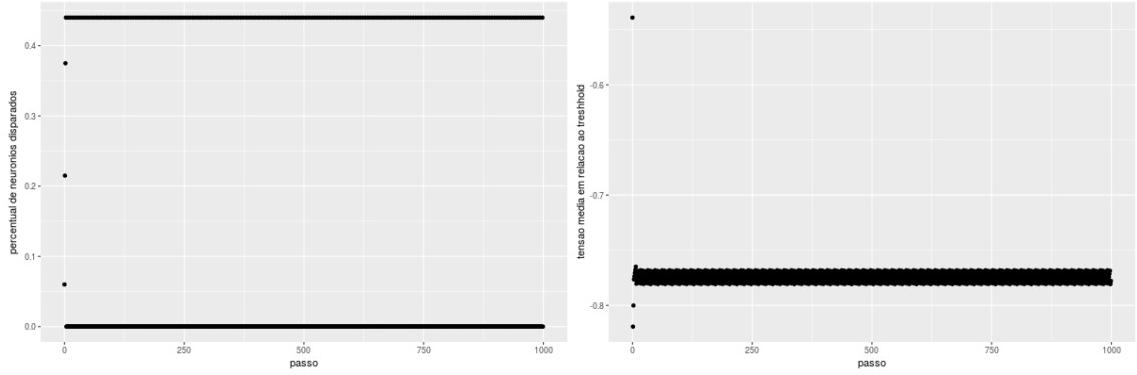


Figure 12: $\rho = 1$

We can see that while the system converged when opinions are pure, for systems with opposite opinions the trigger graph is a very high frequency oscillator, showing that a highly divided and connected population will fully agree between those that share their opinions, but their triggers will act as a kind of action and reaction system, while on a non connected graph the mean information of the system is close to 0 as expected, since you don't have dissemination of information there is no 'formation of groups who share the same idea ("echo chambers")'

3 Conclusion

In this work we showed how in a highly connected population the information of a group is synchronized even without the presence of leaders, it was also show how a low connectivity population creates a more diverse set of ideas about a certain topic, as well as unlike the single opinion systems which eventually have the opinion synchronized with enough connectivity, systems with two opposite opinions don't have this equilibrium, but behave like a high frequency oscillator.

References